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13 ABSTRACT (Maximum 200 words)

Work on solar activity forecasting has concentrated on the search for correlations which would allow the forecast of a given cycle with an anticipation larger than 4 to 5 years. The work on solar dynamo modeling involved a formulation of a realistic model of magnetic diffusion. This work is essentially complete and is capable of handling reliably the saml1 scale interaction between convection and magnetic fields. Significant progress has occurred in the Solar Disk Sextant work with the completion of the wedge fabricated by optical contact. A successful balloon flight has yielded 20 gigabytes of data for which reduction and analysis methods are being developed.

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TECHNICAL REPORT

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Considerable progress has been made during the past year in all three of our undertakings.

1. Solar Activity Forecasting

Until the next solar minimum is reached and confirmed, at which time we will be able to forecast the magnitude and timing of cycle 23, our efforts on this topic have concentrated in the search for correlations which, on the basis of the "extended activity cycle", would allow us to forecast the characteristics of a given cycle much prior to the time of the previous minimum, i.e., with an anticipation much larger than 4-5 years. Despite having tested most conceivably related cycle parameters, on a purely statistical basis, the search has been a disappointing failure. Any progress in this task requires a model, which we must build on the basis of what we have learned from understanding the correlation that we have found between the polar solar magnetic field at activity minimum and the level of the subsequent maximum. In particular, we are attempting to build a new kinematic model in which the source of the dynamo process is located at intermediate latitudes rather than at the poles, and this source produces waves of activity that migrate both to the poles and to the equator, with the former being much faster than the latter. We are now trying to obtain observations to validate this hypotesis, and incorporate the essential features into a viable model.

2. Solar Dynamo Modeling.

The final touches in our formulation of a realistic model for magnetic diffusion turned out to require a lot more modeling and care than we had anticipated. This work is now really complete, and it is capable of handling quite reliably the small scale interaction between convection and magnetic fields. As stated in earlier reports, for the larger scale interactions required to model the dynamo, two additional tasks must be completed. First, since dynamo action is intrinsically a three dimensional effect, the governing equations must be solved, in three dimensions with adequate resolution. This computationally demanding task has been completed, and tested, and considerable effort has been made in optimizing the computational resources by reformulating the code with the Cray YMP supercomputer architecture in mind. Second, because of the large time and length scales of the global fields, it is necessary to develop a realistic way of suppressing the short time and length scale phenomena (which are introduced by solving the more realistic equations with the effects of stratification and compressibility). Having shown that the commonly adopted "anelastic" approximation is not self-consistent, we are currently developing and testing an approximation which is both computationally tractable, and valid.

3. Solar Disk Sextant.

Significant progress has occurred in the SDS work. We completed the wedge fabricated by optical contact, and proceeded to integrate it into the SDS. We carried out a balloon flight on September 30 from Fort Sumner, NM. The flight was highly successful, and about 20 Gbytes of data were obtained. Since that time, we have been developing reduction and analysis methods capable of yielding the best possible accuracy. Having settled on a reduction procedure, we are currently reducing this high volume of data. We can clearly see for each rotation the effects of the solar oblateness and differential refraction, even at the 5 mb atmospheric pressure experienced during most of the flight. We expect to be able to measure the solar oblateness with sufficient precision to ascertain the existence or absence of a fast spinning core within the Sun. Moreover, with the improved stability now achieved for the SDS, between this and subsequent flights, we are ready to begin the search for structural changes within the Sun expected to occur as the field from the present cycle decays, or as the dynamo begins to build up toward the next cycle.